MODEL 187 LIQUID LEVEL CONTROLLER

INSTALLATION, OPERATION, AND MAINTENANCE INSTRUCTIONS

American Magnetics, Inc.

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March 1998

Model 187 Configuration

AMI Order Number:_____ Shipping Date:_____

Model 187 Serial #:_____ Firmware Revision:_____

Input Power Requirements:_____

Sensor Length (mm):_____

Calibration Passcode:_____ Maximum Dielectric: _____

Configuration Notes:

_____

_____

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AMI Warranty

All products manufactured by AMI are warranted to be free of defects in materials and workmanship and to perform as specified for a period of one year from date of shipment. In the event of failure occurring during normal use, AMI, at its option, will repair or replace all products or components that fail under warranty, and such repair or replacement shall constitute a fulfillment of all AMI liabilities with respect to its products. Since, however, AMI does not have control over the installation conditions or the use to which its products are put, no warranty can be made of fitness for a particular purpose, and AMI cannot be liable for special or consequential damages. All warranty repairs are F.O.B. Oak Ridge, Tennessee, USA.

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Foreword

Purpose and Scope

This manual contains the operation and maintenance instructions for the American Magnetics, Inc. Model 187 Liquid Level Controller. The manual outlines the instructions for instrument use in various system designs. Since it is impossible to cover all possible system/sensor designs, the most common configuration is discussed and the user is encouraged to contact an authorized AMI Technical Support Representative for information regarding specific configurations not explicitly covered in this manual.

Contents of This Manual

Introduction introduces the reader to the functions and characteristics of the instrument. It provides the primary illustrations of the front and rear panel layouts as well as documenting the performance specifications.

Installation describes how the instrument is unpacked and installed in conjunction with ancillary equipment in a typical cryogenic system.

Operation describes how the instrument is used to measure and control liquid level. *All* instrument displays and controls are documented.

Remote Interface Reference documents all remote commands and queries available through the RS-232 and IEEE-488 interfaces. A quick-reference summary of commands is provided as well as a detailed description of each.

Service provides guidelines to assist the user in troubleshooting possible system and instrument malfunctions. Information for contacting AMI Technical Support personnel is also provided.

The ***Appendix*** documents the rear panel connectors.

Applicable Hardware

The Model 187 has been designed to operate with an AMI Liquid Level Sensor. Operation with other equipment is not recommended and may void the warranty.

General Precautions

Cryogen Safety

Personnel handling cryogenic liquids should be thoroughly instructed and trained as to the nature of the liquids. Training is essential to minimize accidental spilling. Due to the coldness of these materials, a cryogen spilled on many objects or surfaces may damage the surface or cause the object to shatter, often in an explosive manner.

Inert gases released into a confined or inadequately ventilated space can displace sufficient oxygen to make the local atmosphere incapable of sustaining life. Cryogenic liquefied gases are potentially extreme suffocation hazards since a small amount of liquid will vaporize and yield a very large volume of oxygen-displacing gas. Always ensure the location where the cryogen is used is well ventilated. Breathing air with insufficient oxygen content may cause unconsciousness without warning. If a space is suspect, purge the space completely with air and test before entry. If this is not possible, wear a forced-air respirator and enter only with a co-worker standing by wearing a forced-air respirator.

Cryogenic liquids, due to their extremely low temperatures, will burn the skin in a similar manner as would hot liquids. Never permit cryogenic liquids to come into contact with the skin or allow liquid nitrogen to soak clothing. Serious burns may result from careless handling. Never touch uninsulated pipes or vessels containing cryogenic liquids. Flesh will stick to extremely cold materials. Even nonmetallic materials are dangerous to touch at low temperatures. The vapors expelled during the venting process are sufficiently cold to burn flesh or freeze optic tissues. Insulated gloves should be used to prevent frost-bite when operating valves on cryogenic tanks. Be suspicious of valves on cryogenic systems; the extremes of temperature they undergo causes seals to fail frequently.

In the event a person is burned by a cryogen or material cooled to cryogenic temperatures, the following first aid treatment should be given pending the arrival and treatment of a physician or other medical care worker:

1. If any cryogenic liquid contacts the skin or eyes, immediately flush the affected area gently with tepid water (102°F – 105°F, 38.9°C – 40.5°C) and then apply cold compresses.

2. Do not apply heat. Loosen any clothing that may restrict circulation. Apply a sterile protective dressing to the affected area.

3. If the skin is blistered or there is any chance that the eyes have been affected, get the patient immediately to a physician for treatment.

Containers of cryogenic liquids are self pressurizing (as the liquid boils off, vapor pressure increases). Hoses or lines used to transfer these liquids should never be sealed at both ends (i.e. by closing valves at both ends).

When pouring cryogenic liquids from one container to another, the receiving container should be cooled gradually to prevent damage by thermal shock. The liquid should be poured slowly to avoid spattering due to rapid boil off. The receiving vessel should be vented during the transfer.

Introduction of a substance at or near room temperature into a cryogenic liquid should be done with great caution. There may be a violent gas boil off and a considerable amount of splashing as a result of this rapid boiling. There is also a chance that the material may crack or catastrophically fail due to forces caused by large differences in thermal contraction of different regions of the material. Personnel engaged in this type of activity should be instructed concerning this hazard and should always wear a full face shield and protective clothing. If severe spraying or splashing could occur, safety glasses or chemical goggles along with body length protective aprons will provide additional protection.

The properties of many materials at extremely low temperatures may be quite different from the properties that these same materials exhibit at room temperatures. Exercise extreme care when handling materials cooled to cryogenic temperatures until the properties of these materials under these conditions are known.

Metals to be used for use in cryogenic equipment application must posses sufficient physical properties at these low temperatures. Since ordinary carbon steels, and to somewhat a lesser extent, alloy steels, lose much of their ductility at low temperatures, they are considered unsatisfactory and sometimes unsafe for these applications. The austinetic Ni-Cr alloys exhibit good ductility at these low temperatures and the most widely used is 18-8 stainless steel. Copper, Monel®, brass and aluminum are also considered satisfactory materials for cryogenic service.

Safety Summary

Cryogenic storage systems are complex systems with the potential to seriously injure personnel or equipment if not operated according to procedures. Proper use of safety mechanisms (pressure relief valves,

rupture disks, etc.) included in the cryostat and top plate assembly are necessary.

Recommended Safety Equipment

- First Aid kit
- Fire extinguisher rated for class C fires
- Leather gloves
- Face shield
- Signs to indicate that there are potentially dangerous cryogens in use in the area.

Safety Legend

Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product or personal injury.

Hazardous voltage symbol.

Alternating Current (Refer to IEC 417, No. 5032).

Off (Supply) (Refer to IEC 417, No. 5008).

On (Supply) (Refer to IEC 417, No. 5007).

Warning

The Warning sign denotes a hazard. It calls attention to a procedure or practice, which if not correctly adhered to, could result in personal injury. Do not proceed beyond a Warning sign until the indicated conditions are fully understood and met.

Caution

The Caution sign denotes a hazard. It calls attention to an operating procedure or practice, which if not adhered to, could cause damage or destruction of a part or all of the product. Do not proceed beyond a Caution sign until the indicated conditions are fully understood and met.

1 Introduction

1.1 Model 187 Features

The American Magnetics, Inc. (AMI) Model 187 Liquid Level Controller system (patent-pending) is an advanced, microprocessor-based solution designed to provide compensated, capacitance-based level monitoring and control of virtually any cryogenic liquid over a *wide range of operating pressures and temperatures*.

1.1.1 Compensated capacitance-based level sensing

The system consists of a Model 187 Liquid Level Controller, sensor, connecting coaxial cables pairs, and an optional solenoid-operated fill valve. The primary instrument sensing element is typically a 3/8 inch (9.5 mm) OD cylindrical capacitor constructed of stainless steel which allows a non-conducting fluid to become the dielectric between the concentric plates.

In addition to the primary cylindrical sensing element, circular-shaped parallel plate capacitors are mounted on the sensing element in order to provide “reference” data to compensate the primary capacitance measurement. The instrument measures the primary sensing element capacitance, compensates for any dielectric variations with respect to the calibration conditions using the “reference” plates, and displays a level reading. The sensors are normally constructed in one-piece lengths of up to 20 feet (6.1 m).

1.1.2 Factory calibration

The Model 187 is designed to be factory calibrated by AMI for a matched sensor and is ready for immediate use upon delivery. The capacitance-based primary and reference sensors provide feedback to the instrument to measure liquid level for any non-conducting liquid and compensate for a wide range of operating conditions — therefore, *no user calibration procedure is required*, but the Model 187 provides the option of a user calibration *in addition to* the factory settings.

All calibration data is password protected to prevent unauthorized modification and is stored in non-volatile memory. The instrument also provides a function to select between the user calibration and the AMI factory calibration.

1.1.3 Convenient display and direct keypad entry

The instrument is equipped with a 16 x 2 backlit character-mode LCD display which provides liquid level and setpoint indication in inches, centimeters, or percent as selected by the user. A front panel keypad interface allows the user to easily view and modify the instrument settings. The default display indicates liquid level and fill/loss rate. The current liquid level is updated and visible in many of the display modes used in configuring various settings of the instrument.

The 4 x 4 keypad is provided for direct entry of values for setpoints, sensor lengths, and other functions. The keypad also provides a convenient menu-type interface for configuring various instrument settings that require selection from a list of options.

1.1.4 Automatic level control

The Model 187 provides four level setpoints, two of which (A & B) are control setpoints used to control liquid level through use of a solenoid-operated fill valve. The remaining setpoints (HI & LO) are alarm setpoints and can be set for other control or alarm functions.

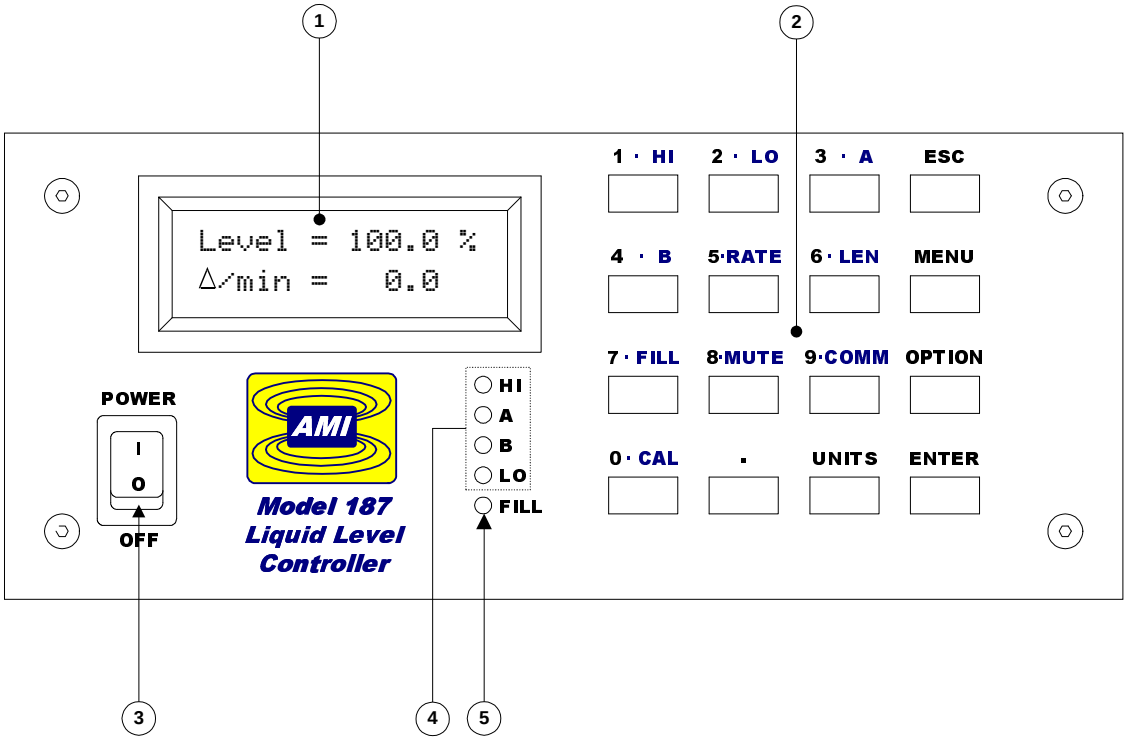
The HI and LO setpoints operate relay contacts in addition to the front panel LED indications. LED indication is also provided for the A setpoint, B setpoint, and automatic controller (FILL) function of the instrument. All setpoints are accessible via the keypad. The automatic controller (FILL) function can also be manually overridden or disabled using the keypad.

A timeout feature is also provided with the automatic controller (FILL) function. The timeout specifies the maximum amount of time necessary for the Model 187 to fill the target vessel to the A setpoint. If fill is not achieved within the timeout period, the Model 187 ends the fill operation (de-energizes the rear panel controller output) and indicates expiration of the timeout feature by blinking the FILL LED and setting the appropriate flags accessible through the serial or GPIB remote interfaces.

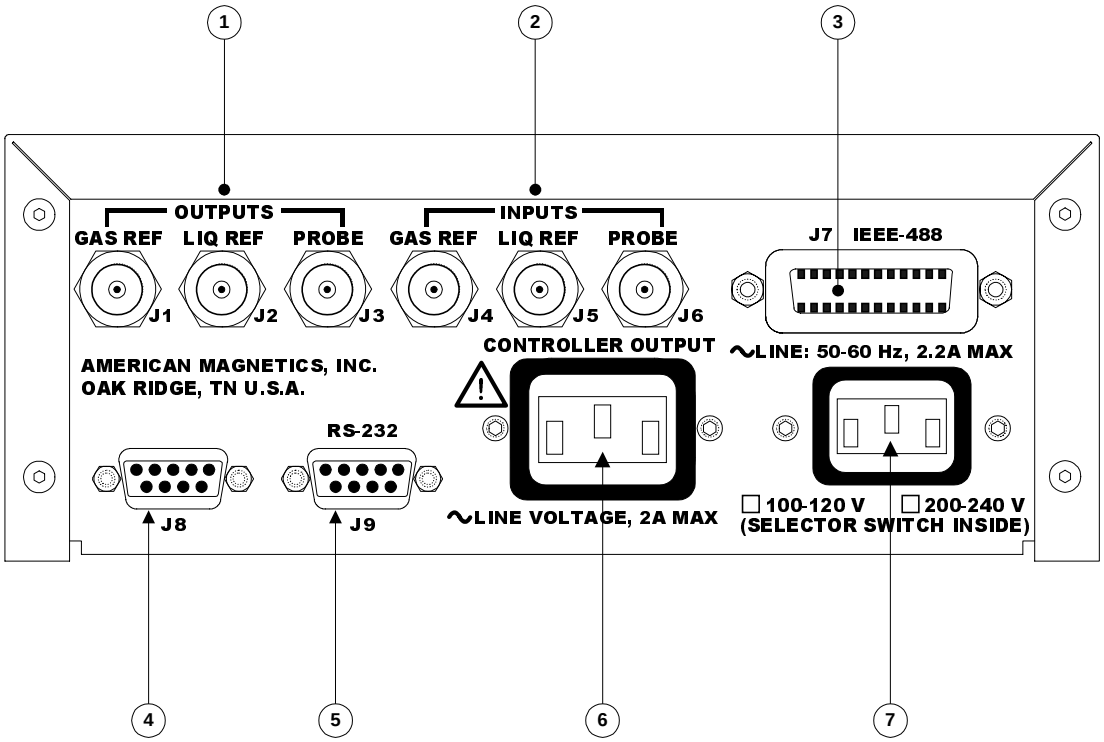
1.1.5 Remote computer monitoring or controlled operation

The Model 187 can be configured to provide an optional analog 0-10 volt DC signal accessible from the rear panel of the instrument for use with a recorder. A 4-20 mA current loop option is available in lieu of the voltage signal.

RS-232 is provided as a standard digital interface for the Model 187. Additional digital interface options, including RS-422 or GPIB (IEEE 488.2 compliant), are available. The serial and GPIB remote interfaces provide a comprehensive command set for monitoring and configuring all functions of the instrument.



1	16 character x 2 line LCD display with backlight	**4**	HI, A, B, and LO alarm LEDs
2	4 x 4 keypad	**5**	FILL Indicator LED
3	Power switch		



1	BNC coaxial connector outputs to sensor	**5**	RS-232 (standard) or RS-422 DB-9 female connector
2	BNC coaxial connector inputs from sensor	**6**	Controller output receptacle (reverse IEC-320)
3	IEEE-488 communications port	**7**	IEC-320 Power cord connector (IEC-320)
4	Auxiliary DB-9 male connector (see *Appendix* for pinout)		

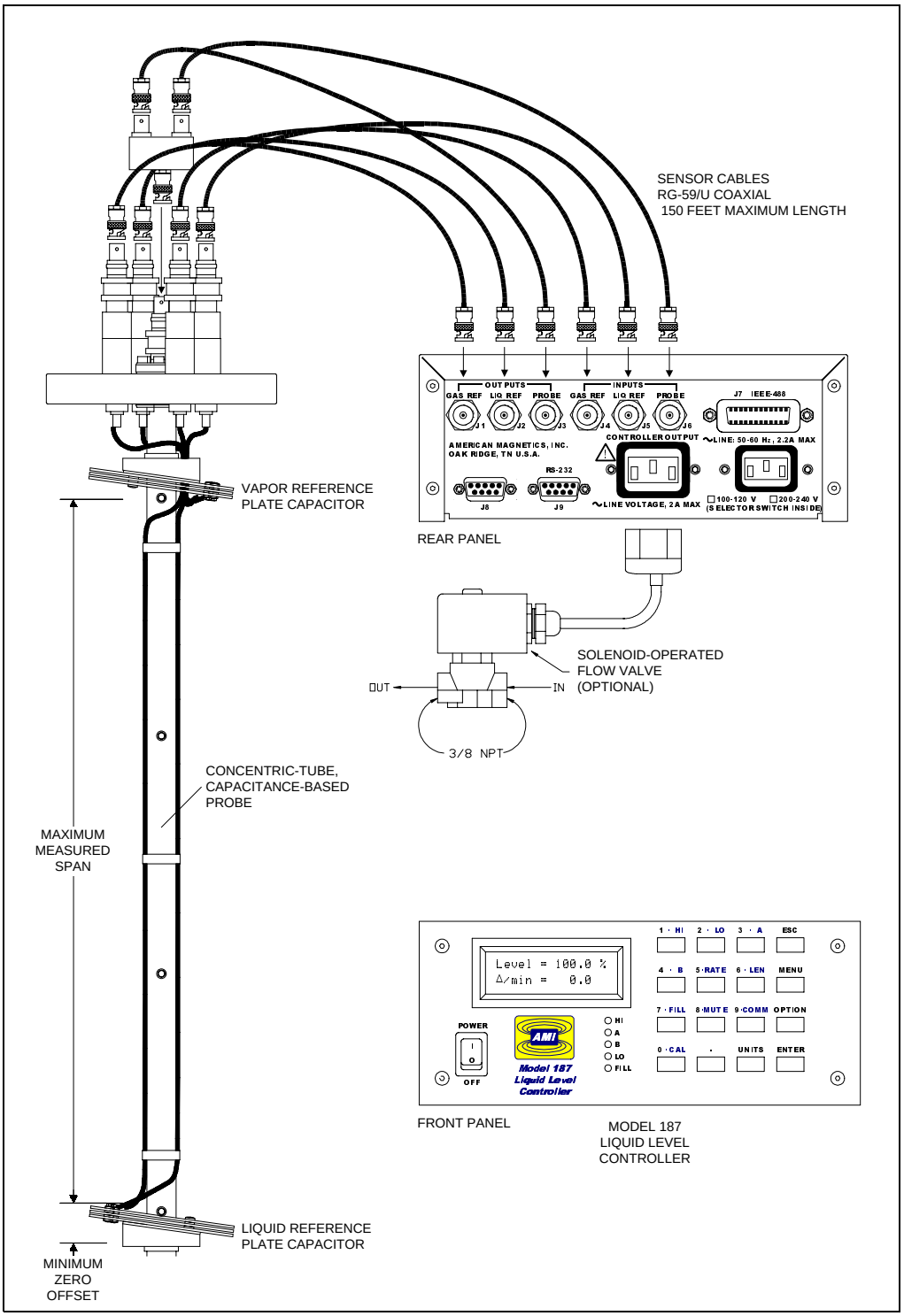


Figure 1-1. Model 187 instrument, control valve, and sensor system diagram.

1.5 Model 187 Specifications @ 25 °C

Level Measurements	
Resolution:	0.1 %, 0.1 cm, or 0.1 in
Accuracy:	± 0.5%
Linearity:	± 0.2%
Temperature Coefficient:	0.1% / °C
Operating Parameters	
HI, A, B, and LO Alarms:	0% to 100% adjustable
HI/LO Alarm Relay Contact Ratings:	10 V at 0.5 A (normally open, closed on alarm)
Controller Output:	AC line voltage @ 2A max current
Fill Timer:	0.1 to 9,999.9 minutes
Analog Output	
Integral Non-linearity:	± 0.012%
Resolution:	16 bits
Total Error:	± 0.25% for 4-20 mA output ± 0.5% for 0-10 V output
Current Drift (4-20 mA):	75 ppm / °C
Voltage Drift (0-10 V):	100 ppm / °C
Power Requirements	
Primary:	100-120 or 200-240 VAC ±10% 50 - 60 Hz, 2.2 A max
Memory Backup Battery:	3.6 Volt AA Lithium Cell
Physical	
Dimensions (Standard):	97 mm H x 213 mm W x 290 mm D (3.8" H x 8.4" W x 11.4" D)
Weight (Standard):	2.0 kg (5.4 lbs.)
Dimensions (Rack Mount):	89 mm H x 483 mm W x 290 mm D (3.5" H x 19" W x 11.4" D)
Weight (Rack Mount):	2.3 kg (6.1 lbs.)
Environmental	
Ambient Temperature:	Operating: 0 °C to 50 °C (32 °F to 122 °F) Nonoperating: –20 °C to 60 °C (–4 °F to 140 °F)
Relative Humidity:	0% to 95%; non-condensing

2 Installation

Warning

Before energizing the instrument, the earth ground of the power receptacle must be verified to be at earth potential and able to carry the rated current of the power circuit. Using extension cords should be avoided; however, if one must be used, ensure the ground conductor is intact and capable of carrying the rated current.

In the event that the ground path of the instrument becomes less than sufficient to carry the rated current of the power circuit, the instrument should be disconnected from power, labeled as unsafe, and removed from place of operation.

Do not operate this instrument in the presence of flammable gases. Doing so could result in a life-threatening explosion.

Do not modify this instrument in any way. If component replacement is required, return the instrument to AMI facilities as described in the Troubleshooting section of this manual.

2.1 Unpacking the Instrument

Carefully remove the instrument, sensor, and interconnecting coaxial cables from the shipping carton and remove all packaging material. A rack mounting kit is supplied if the instrument was purchased with the rack mount option.

Note

If there is any shipping damage, save all packing material and contact the shipping representative to file a damage claim. Do not return the instrument to AMI unless prior authorization has been received.

If the chassis is a table top model, place the instrument on a flat, secure surface.

2.2 Rack Mounting the Instrument

If the instrument has a rack mount chassis, follow the following procedure:

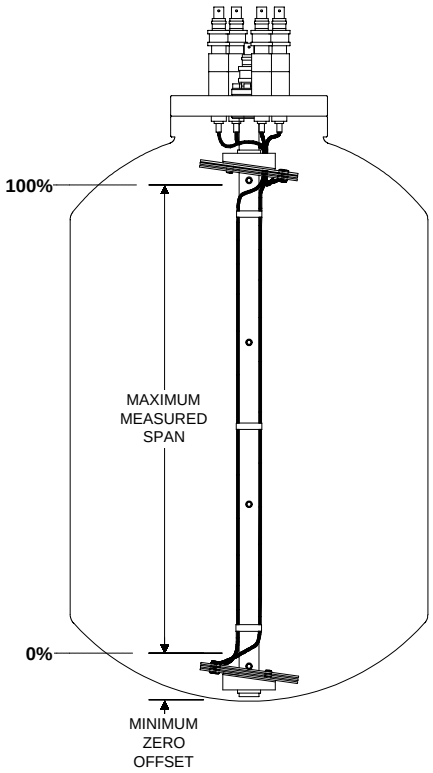
a. Attach the rack mount adapter pieces to the instrument by first removing the four screws on the side of the instrument that attach the cover to the chassis. Attach the rack mount adapter pieces to the sides of the instrument by reinstalling the screws.

b. Install the instrument in a 19" rack by securing the front panel to the rail in each of the four corners with mounting hardware supplied by the cabinet manufacturer.

Warning

Do not remove the cabinet feet and then reinsert the original screws. Doing so could present a severe life-threatening electrical hazard. If removal of the cabinet feet is desired, replace the original screws with screws not to exceed 1/4" in length. Screws longer than 1/4" will contact and damage the printed circuit board inside the unit.

2.3 Installing the Sensor



Exercise care when installing the sensor since dents, crimps, bends or other physical distortions in the cylindrical and plate sensors will change electrical characteristics and possibly cause calibration errors and/or disruption of proper instrument operation. It is also important to ensure that the sensor is installed in a vertical orientation for optimal operation of the sensors. Make a note of the 0% and 100% points of the target vessel per diagram at left. Before installing the sensor and before filling the target vessel, the user may first want to review the *Operation* section—especially the zero offset and measured span length settings discussed on page 14.

Drawings will be provided for custom sensor or mounting flange designs.

2.4 Connecting the Model 187 to the Sensor

Note

The electrical characteristics of the interconnecting coaxial cables are temperature dependent over extreme ranges and the cables may become brittle at cryogenic temperatures. The cables should be mounted in such a manner as to avoid large temperature gradients such as those encountered in the path of dewar vents.

Caution

Operation of the AMI Model 187 Liquid Level Instrument with a device other than an AMI Liquid Level Sensor may void the instrument warranty.

Connect the Model 187 to the sensor using the six supplied RG-59/U coaxial cables. Ensure the cables are connected to the correct sensor and instrument BNC connector (see Figure 2-1 below and page 5 for a system diagram). The numbers shown in Figure 2-1 will be metal-stamped on the sensor top-plate and probe cable adapter.

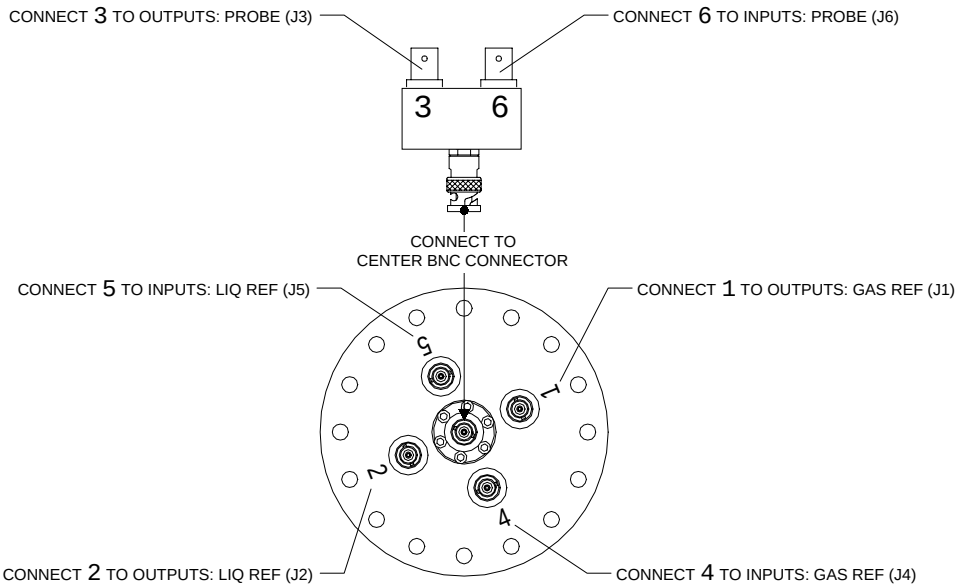


Figure 2-1. Diagram of sensor top-plate and cable connections.

Caution

Moisture or contaminants in any of the BNC coaxial connectors can short the measurement and cause erroneous readings. A pack of non-conductive electrical connection lubricant (ECL) has been

included with the liquid level sensor packaging to reduce the possibility of this occurring. If the sensor is operated in an environment where it will be exposed to moisture or other contaminants, AMI recommends applying a small amount of ECL to any of the BNC connectors that may be exposed. Mate the doped connectors and then remove any excess ECL from the outside of the connector. Added protection can be achieved by covering the doped connections with a short section of heat-shrink tubing.[1]

2.5 Installing the Optional Solenoid-Operated Fill Valve

Install the solenoid-operated fill valve by connecting the valve power cable to the AC controller output receptacle on the rear panel of the instrument. The standard AMI supplied valve has a 9/32 inch orifice and the input and output are tapped for 3/8 NPT.

Caution

When using a solenoid-operated control valve with the Model 187, ensure the valve is configured for the operating voltage of the Model 187. Failure to do so will result in faulty operation and may also result in valve damage.

Warning

Before touching any of the controller output receptacle terminals or touching the wiring connected to these terminals, remove power to the instrument by unplugging it or turning the power switch to the off position.

The controller output receptacle conducts hazardous AC line voltage potentials. It is for use with equipment which has no live parts which are accessible. Conductors connected to its terminals must be insulated from user contact by reinforced or double insulation capable of withstanding 4250 V (impulse) for a 230 VAC Category II installation, or 2550 V (impulse) for a 120 VAC Category II installation.

This instrument is designed for operation from a single-phase power source for maximum safety. The controller output receptacle circuitry only switches the "line" ("hot") connection to the AC mains. If two-phase power is applied, any equipment connected to the controller output receptacle conducts hazardous AC voltage even when the controller output receptacle is not energized.

1. MSDS sheets for the ECL are available upon request.

2.6 Connecting the Instrument to Power

Warning

The Model 187 operates on 50-60 Hz power and may be configured for 100-120 or 200-240 VAC ±10%. The power requirements for each instrument is marked on the calibration sticker on the bottom of the instrument. Verify that your instrument is configured for your power source prior to plugging in the line cord. Do not fail to connect the input ground terminal securely to an external earth ground.

Verify that the instrument is configured for the proper operating voltage by referring to the calibration sticker affixed to the bottom of the instrument. If the operating voltage is correct, plug the line cord into the appropriate power receptacle.

If the instrument operating voltage needs to be changed, ensure the instrument is de-energized by disconnecting the power cord from the power source. Remove the instrument cover and slide the voltage selector switch on the main printed circuit board to the proper voltage. Replace the instrument cover.

3 Operation

3.1 Operational Guidelines

This section describes the front panel display and kepad functions for the Model 187. In addition to the front panel operation described, the remote communication ports provide methods for performing the identical operations and acquiring the current state of the instrument. Refer to the Remote Interface section beginning on page 27 for more details regarding the communication functions.

3.1.1 Energizing the instrument

After completion of the *Installation* procedures, energize the instrument by placing the power switch in the POWER (**I**) position. The LCD display will briefly display the instrument name and ROM revision and all LEDs will be energized. The Model 187 will then begin level and usage measurements and update the default display as illustrated below:

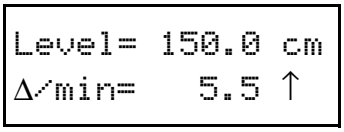


Figure 3-1. Default display showing level (in cm) and usage (cm per minute).

In order to access the various menus for setting the alarms, setpoints, fill mode, etc. press a key while the default display is visible. Pressing a key while the default display is visible activates the associated menu display, e.g. pressing the **1•HI** key while the default display is visible enters the HI menu. Press the **ESC** key to exit a menu and return to the default display.

For more information regarding entering menus, exiting menus, entering numerical values, and selecting menu options, refer to the Menu Reference section beginning on page 18.

> **Note**
>
> *If the displayed level reading is below the LO alarm level or exceeds the HI alarm level, an audible alarm will sound continuously. To silence the alarms, see the MUTE menu description on page 22.*

The Model 187 is calibrated at the factory for the specific sensor supplied with the unit for use in a target liquid. If the USER calibration is desired, see paragraph 3.3.11 on page 24.

3.1.2 Selecting the Appropriate Units

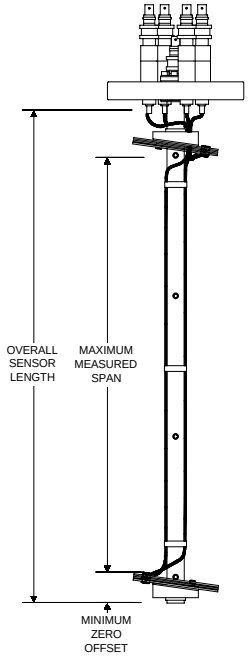
Repeatedly press the **UNITS** key to cycle between display units of percent, inches, or centimeters. The level reading displays the sensor length, or percentage of the measured span, above the zero offset that is immersed in liquid (see diagram below).

The selected units may be changed at any time except during the process of entering a numerical value.

3.1.3 Configuring the Length Settings

The Model 187 *must* be configured with appropriate values for the *zero offset* and *measured span* settings. AMI records the overall length for the sensor on the first page of this manual as well as on the calibration label affixed to the bottom of the Model 187 chassis. AMI has also preset the minimum zero offset and maximum measured span to match the purchased sensor.

Overall Sensor Length	This is the total active region of the concentric-tube, capacitance-based probe. This value is recorded on the first page of this manual and on the instrument's calibration label.
Zero Offset	Measured from the bottom of the probe to a minimum of just above the liquid reference plates. The liquid reference plates must remain submerged at all times for proper operation.
Measured Span	Measured from the top of the zero offset (zero point) to a maximum of just below the vapor reference plates. The vapor reference plates must remain exposed at all times for proper operation. Levels are expressed as a percentage of the measured span submerged in liquid.



The zero offset and measured span settings can be modified by the user and are accessible by pressing the **6•LEN** key.

Note

The LEN (length) menu adjustments can only be performed in the inches or centimeter units modes. The length adjustments are inactive if the units are set for %, and the instrument will beep indicating that the LEN menu cannot be entered.

3.1.4 Configuring the HI and LO Alarms

To adjust the HI and LO alarm levels, use the HI and LO menus accessible by using the **1•HI** and **2•LO** keys, respectively. The setpoints may be located anywhere between 0% to 100% of the measured span. The HI and LO alarm adjustments are compatible with all three units modes.

a. When the measured liquid level exceeds the HI alarm, the HI LED on the front panel is energized and a set of relay contacts are closed on the 9-pin D-sub connector J8 on the rear panel (see the *Appendix* for the pinout). When the level reaches or falls below the HI alarm, the LED is extinguished and the relay contacts open.

b. When the measured liquid level falls below the LO setpoint, the LO LEVEL LED on the front panel is energized and a set of relay contacts are closed on the 9-pin D-sub connector J8 on the rear panel (see the *Appendix* for the pinout). When the level reaches or exceeds the LO setpoint, the LED is extinguished and the contacts open.

Note

The HI and LO contacts are both closed on power-off of the instrument which is a state unique to the power-off condition.

Note

If the length settings are adjusted subsequent to configuring the various settings, the percentage of the measured span will be maintained for all alarms or setpoints. For example, if the measured span is set to 100 cm and the HI alarm is set to 80 cm, then adjusting the measured span to 150 cm will result in the HI alarm being automatically scaled to 120 cm—i.e. the setting of 80% of the measured span is retained.

3.1.5 Configuring the A and B Setpoints

The A and B setpoints, which specify the upper and lower limits for the liquid level control band, are accessible via the **3•A** and **4•B** keys. The A and B setpoint adjustments are compatible with all three units modes.

a. When the measured liquid level reaches or exceeds the A setpoint, the A LED on the front panel is energized. When the level falls below the A setpoint, the LED is extinguished.

b. When the measured liquid level falls below the B setpoint, the B LED on the front panel is energized. When the level reaches or exceeds the B setpoint, the LED is extinguished.

c. In addition to the LED functions, the controller output receptacle may be energized and de-energized as discussed in paragraph 3.1.6 below.

Note

The A setpoint must always be above the B setpoint. The firmware does not allow these setpoints to be reversed. Both may be set from 0% to 100% as long as A > B.

3.1.6 Selecting the Fill Mode

The operational mode of the controller output receptacle of the instrument is controlled by the FILL menu accessible via the **7•FILL** key. Operation of the fill modes is as follows:

a. **OFF** (or **CLOSED**)**:** With the instrument power on and the fill mode OFF, the instrument serves only as a level monitor, providing a level reading on the display and providing data via any analog or digital communication options installed. All four setpoint LEDs (and associated J8 connector relay contacts) operate normally, however, the controller output receptacle on the rear panel will *always* be de-energized.

b. **ON** (or **OPEN**)**:** With the fill mode set to ON, the rear panel controller output receptacle will become energized, thereby initiating flow if the solenoid-operated fill valve is properly connected. The FILL LED on the front panel will energize indicating the presence of power at the controller output receptacle. **The operator is solely responsible for terminating the fill flow.**

c. **AUTO:** With the fill mode set to AUTO, the instrument is capable of automatically initiating and terminating liquid fill via the control valve, thereby maintaining the level between the selected A and B setpoints. If the liquid level falls below the B setpoint, the rear panel controller output receptacle and front panel FILL LED are energized. When the liquid level subsequently reaches or exceeds the A setpoint, the controller output receptacle is de-energized and the FILL LED is extinguished.

3.1.7 Configuring the Fill Timer

A fill time-out setting of up to 9,999.9 minutes is provided to help alleviate the possibility of liquid overflow. The timeout setting is accessible in the FILL menu, and may be entered by pressing the **7•FILL** key followed by the **MENU** key.

The fill timeout feature is enabled when the instrument is operated in the AUTO mode with a fill timeout setting greater than zero. Once the liquid level falls below the B setpoint, an internal fill timer (whose period is the timeout setting) begins to increment. If the liquid level does not reach the A setpoint before the timeout period expires, the FILL LED will begin blinking and power to the rear panel controller output receptacle will be interrupted. To reset this function the fill mode must be momentarily changed to the ON state, the OFF state, or power to the instrument must be momentarily turned off.

> **Note**
>
> *The fill timeout function is disabled when the timeout setting is zero, i.e. the Model 187 will continue to fill the target vessel until the A setpoint is achieved. Adjusting the fill timeout setting to zero, while an AUTO fill is in progress, will also terminate any in-progress functions of the timer.*

The instrument is shipped from the factory with a zero setting for the fill timeout.

3.2 Sensor contamination

To ensure proper instrument calibration and operation, care must be taken to ensure the sensor is kept free of contaminants and not subjected to any force which would physically distort the sensor. Water or other electrically conducting substances in the sensor will disturb the measured capacitance and therefore instrument response. Physically distorting the sensor in any way will also cause abnormal instrument operation by introducing variations in the sensor capacitance not due to liquid level. The absolute calibration of the instrument can be inaccurate if care is not taken to ensure the sensor is in a proper environment.

Cold sensors exposed to humidified air can show erroneous high level readings due to the fact that the air contains moisture which can condense between the cold sensing tubes. A small film of water can cause a shorted or partially shorted condition, which results in false level readings. As the sensor warms, the moisture may evaporate and the sensor will again read correctly. This is a physical phenomenon and does not indicate any problem with your AMI level equipment. Limit or eliminate exposure of cold sensors to humidified air to avoid this condition.

If a sensor should require cleaning, flushing with alcohol is recommended. The sensor cannot be used again until all the alcohol has been evaporated. Under no circumstances should the sensor be disassembled.

3.3 Menu Reference

The default display is illustrated in Figure 3-2 below. The default display provides the level measurement in the selected units, and a usage estimate in the selected units per minute. An arrow displayed to the right of the usage estimate indicates the usage trend. The operating values on the left side of the display are always visible during any mode of operation or menu selections.

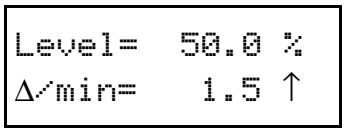


Figure 3-2. Default display showing level (in %) and usage (% per minute).

3.3.1 Accessing Menus

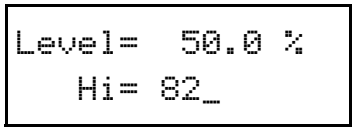
Menus are accessed by pressing the appropriate key while the default display is visible. Once a menu is entered, the numerical keys will enter the associated number into the display. Using the **ESC** key (while no numerical entry is in progress) to exit a menu and return to the default display.

For example, if the **1•HI** key is pressed while the default display is visible, the HI menu is displayed. Pressing the **1•HI** key in the HI menu results in a numerical entry of the "1" digit.

Some menus have multiple screens associated with the function. To move to the next menu, press the **MENU** key. Repeatedly pressing the **MENU** key will cycle through all the menu screens associated with the function.

3.3.1.1 Entering Numerical Values

A common method of entering values is used within menus requiring numerical entries. Once a menu is selected, the user starts an entry by pressing a digit or the decimal key. The display will begin a new entry and display a cursor _ as a prompt for the next digit or decimal entry. To accept the entered value, press the **ENTER** key. Values are *not* applied to the operation of the instrument until the **ENTER** key is pressed and the cursor prompt disappears from the display. An example of an entry in progress is illustrated below:



If the **ESC** key is pressed *once* while entry is initiated, the entered digits will be cleared and the cursor will remain for reentry of a new desired value. If the **ESC** key is depressed *twice*, the setting will revert to the previous value and the entry is cancelled.

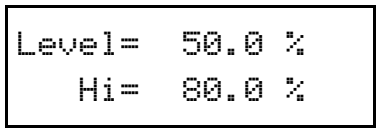
3.3.1.2 Menu Option Selection

Some menus may require the user to cycle through and select from a list of predefined options. Such menus will display a cursor ▶ which indicates that a list of predefined options are available from which to select. Pressing the **OPTION** key moves the cursor forward within the list. The value to which the cursor points is the specified setting and is effective *immediately* upon selection.

3.3.1.3 Exiting Menus

Menus are exited by pressing the **ESC** key while no numerical entry is in progress. The display will revert to the default display (see paragraph 3.3 above).

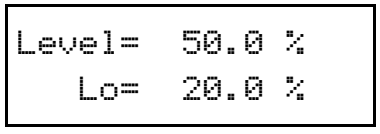
3.3.2 HI Menu



Accessible by pressing the **1•HI** key. The "HI" menu adjusts the HI alarm level in the selected units. When the measured liquid level exceeds the HI alarm, the HI LED on the front panel is energized and a set of relay contacts are closed on the 9-pin D-sub connector J8 on the rear panel (see the *Appendix* for the pinout). When the level reaches or falls below the HI alarm, the LED is extinguished and the relay contacts open.

The HI alarm may be set between 0.0% to 100.0%. The default setting is 80.0%.

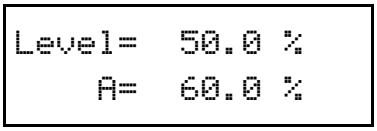
3.3.3 LO Menu



Accessible by pressing the **2•LO** key. The "LO" menu adjusts the LO alarm level in the selected units. When the measured liquid level falls below the LO setpoint, the LO LEVEL LED on the front panel is energized and a set of relay contacts are closed on the 9-pin D-sub connector J8 on the rear panel (see the *Appendix* for the pinout). When the level reaches or exceeds the LO setpoint, the LED is extinguished and the contacts open.

The LO alarm may be set between 0.0% to 100.0%. The default setting is 20.0%.

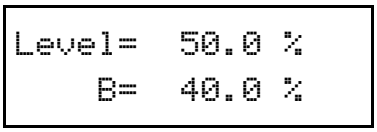
3.3.4 A Menu



Accessible by pressing the **3•A** key. The "A" menu adjusts the A setpoint level in the selected units, which defines the upper limit of the automatic fill function control band. When the measured liquid level reaches or exceeds the A setpoint, the A LED on the front panel is energized. When the level falls below the A setpoint, the LED is extinguished. If the FILL mode is set to AUTO, the A setpoint functions as the upper limit of a fill cycle.

The A setpoint may be set between 0.0% to 100.0%, but must be greater than the B setpoint. The default setting is 60.0%.

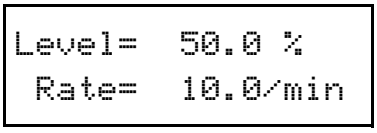
3.3.5 B Menu



Accessible by pressing the **4•B** key. The "B" menu adjusts the B setpoint level in the selected units, which defines the lower limit of the automatic fill function control band. When the measured liquid level falls below the B setpoint, the B LED on the front panel is energized. When the level reaches or exceeds the B setpoint, the LED is extinguished. If the FILL mode is set to AUTO, the B setpoint functions as the lower limit of the fill function, and thereby initiates a fill cycle.

The B setpoint may be set between 0.0% to 100.0%, but must be less than the A setpoint. The default setting is 40.0%.

3.3.6 RATE Menu



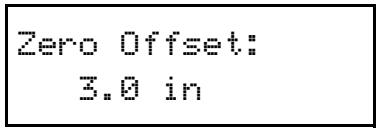
Accessible by pressing the **5•RATE** key. The RATE menu adjusts the RATE alarm in the selected units per minute. The RATE alarm applies to both fill and loss usage estimates. If the usage estimate exceeds the RATE alarm limit, then an alarm symbol appears to the right of the usage estimate in the default display.

The RATE alarm may be set up to 9,999.9% per minute. The default value is 10.0% per minute.

3.3.7 LEN (Length) Menu

The LEN menu is accessible by pressing the **6•LEN** key while in selected units of inches or centimeters. The LEN menu provides access to two menu screens, accessible by pressing the **MENU** key, for the zero offset and measured span settings. For a complete discussion of the zero offset and measured span settings, refer to paragraph 3.1.3 on page 14.

3.3.7.1 Zero Offset



Adjusts the value of the zero offset in the selected units. The zero offset may not exceed the overall length of the sensor minus 1 millimeter. If the sum of the new zero offset and the previous measured span exceeds the overall sensor length, the measured span is automatically reduced to accomodate the new zero offset value.

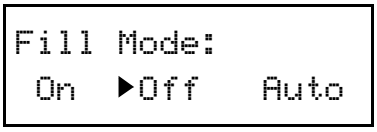
3.3.7.2 Measured Span

Adjusts the value of the measured span in the selected units. The measured span may not exceed the overall length of the sensor specified in the first page of this manual and on the calibration label affixed to the bottom of the Model 187 chassis. If the sum of the new measured span and the previous zero offset exceeds the overall sensor length, the zero offset is automatically reduced to accommodate the new measured span value.

3.3.8 FILL Menu

The FILL menu is accessible by pressing the **7•FILL** key. The FILL menu provides two menu screens, accessible by pressing the **MENU** key, for setting the fill mode and the fill timeout. See paragraph 3.1.3 on page 14 for more discussion of the fill mode and fill timer operation.

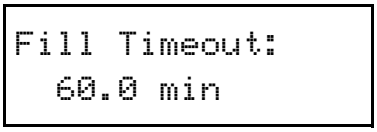
3.3.8.1 Fill Mode



The fill mode menu provides three options for the fill mode of the Model 187. Press the **OPTION** key to cycle between the three selections The FILL LED indicates the energized or de-energized state of the controller output receptacle.

On:	Energizes the controller output receptacle.
Off:	De-energizes the controller output receptacle.
Auto:	Allows the Model 187 to perform the automatic fill function based on the A & B control band settings.

3.3.8.2 Fill Timeout



Adjust the fill timeout setting for the AUTO fill mode. If the A setpoint is not achieved within this period, the controller output receptacle is de-energized and the FILL LED blinks. Setting the fill timeout to zero allows the AUTO fill mode function to continue the fill operation indefinitely until the A setpoint is achieved.

The fill timeout may be set to up to 9,999.9 minutes. The default setting is 0.0 minutes (i.e. no timeout).

3.3.9 MUTE Menu

The MUTE menu is accessible by pressing the **8•MUTE** key. Provides two selections using the **OPTION** key. If the alarms are audible, then the HI and LO alarms will cause the Model 187 to emit a continuous tone. Error conditions will continue to be reported by a short beep even if the alarms are muted.

3.3.10 COMM Menu

The COMM settings, accessible by pressing the **9•COMM** key in the default display mode followed by repeated use of the **MENU** key, allows specification of parameters associated with the display, the IEEE-488

remote interface, and the serial remote interface. Consult Section 4 for more information regarding the communication interfaces.

3.3.10.1 Display Contrast

Adjusts the contrast of the liquid crystal display from 0 to 100%. The default setting is 80%.

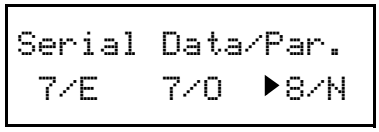
3.3.10.2 IEEE-488 Address

Specifies the IEEE-488 primary address of the Model 187. The valid range is from 0 to 30. The Model 187 should be assigned a unique primary address on the IEEE-488 bus. The default primary address is 22. The Model 187 does not support secondary addressing.

3.3.10.3 Serial Baud Rate

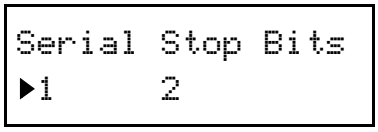
Specifies the baud rate of the serial interface. Use the **OPTION** key to cycle between 1200, 2400, 4800, and 9600 baud (the settings are grouped in pairs). The default value is 9600 baud.

3.3.10.4 Serial Data Bits/Parity



Specifies the number of data bits and parity for the serial interface. Use the **OPTION** key to cycle between values of 7 data bits/even parity (7/E), 7 data bits/odd parity (7/O), and 8 data bits/no parity (8/N). The default setting is no 8 data bits/no parity.

3.3.10.5 Serial Stop Bits



Specifies the number of stop bits for the serial interface. Use the **OPTION** key to cycle between values. The default value is 1 stop bit.

3.3.10.6 Serial Handshaking

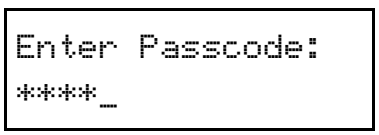
Specifies whether the serial interface uses no handshaking or software flow control (commonly referred to as XON/XOFF). Hardware flow control (i.e. using RTS/CTS) is not supported. Use the **OPTION** key to cycle between values. The default setting is none.

3.3.11 CAL Menu

The Model 187 is factory calibrated by AMI to match a specific sensor. However, the Model 187 also provides a USER calibration function for installations where a user may want to perform a calibration when all sensor equipment is completely installed.

Typically, the user will not need to perform a USER calibration. AMI recommends using the FACTORY calibration unless directed otherwise by an Authorized AMI Technical Support Representative.

The CAL menu is accessed by pressing the **0•CAL** key. The CAL menu first requires that the user enter the 4-digit calibration passcode recorded in the first page of this manual. Key in the calibration passcode and press **ENTER**. Note that the passcode is not displayed during entry, but asterisks (*) are displayed indicating entry of each digit as illustrated below.



Note

All measurements are suspended once the CAL menu has been entered (including the passcode entry screen). All measurements restart when the CAL menu is exited.

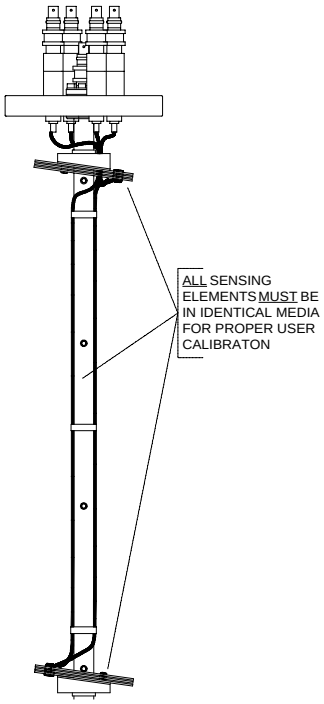
After entry of the correct passcode and the **ENTER** is pressed, the calibration selection menu will appear as shown below:

```
Calibration:
 User  ▶Factory
```

The **OPTION** key can be used to select between the USER and FACTORY calibrations. The selected calibration is retained between power-ups of the instrument.

If a USER calibration has never been performed (which is the default state from the factory), then the first time the USER calibration is selected the user will be presented with the following screen:

```
Press <ENTER> to
Initiate Cal
```



In order the complete the USER calibration, the user should verify that all sensing elements of the installed AMI sensor are connected and are in an identical media. Once the **ENTER** key is pressed (the user may also exit at this point by pressing the **ESC** key and no calibration will be performed) the Model 187 will display the calibration progress, automatically exit the CAL menu, and begin measurements using the new USER calibration.

Note

If all sensing elements of the AMI sensor are not in the identical media, the calibration will be inaccurate and result in errors in the measured liquid level. AMI performs and recommends all user calibrations be done in air or other non-stratified gas with a dielectric that approaches 1.0.

The USER calibration can be re-performed by first selecting the USER calibration in the calibration selection menu, and then pressing the **MENU** key. This will present the "*Press <ENTER> to Initiate Cal*" prompt and again perform a USER calibration once the **ENTER** key is pressed.

4 Remote Interface Reference

The Model 187 provides the capability of supporting RS-232 and IEEE 488.2 compliant interfaces simultaneously. Upon request, the RS-232 port can be reconfigured for RS-422 operation. Separate output buffers are provided for the serial and IEEE-488 return data. However, for optimal performance and simplicity of programming, AMI normally recommends limiting operation to one interface. An exception to this recommendation would be using the serial port as a debugging aid during programming of the IEEE-488 port (or vice-versa), which can prove to be a useful resource.

4.1 SCPI Command Summary

The following manual conventions are used for SCPI (*Standard Commands for Programmable Instruments*) syntax for the remote interface commands:

- Braces { } enclose valid parameter choices.
- A vertical bar | separates multiple choices for each parameter.
- Triangle brackets < > indicate that you must supply a value.

For example, the command `UNITs {0|1|2}` indicates that the command `UNITs` has three parameter options: `0`, `1`, or `2`. Refer to the detailed description of each command for information regarding specific parameter choices and their meanings. Capitalized portions of the commands indicate acceptable abbreviations. Default settings are shown in bold.

System-Related Commands

(see page 40 for more information)

```
*IDN?
*RST
*TST?
<Ctrl-C>

SYSTem:LOCal
SYSTem:REMote
SYSTem:ERRor?
```

Status System Commands

(see page 41 for more information)

```
*STB?
*SRE <enable_value>
*SRE?

*CLS

*ESR?
*ESE <enable_value>
*ESE?

*PSC {0|1}
*PSC?
*OPC
*OPC?

STATus:ALARm:CONDition?
STATus:ALARm:EVENt?
STATus:ALARm:ENABle <enable_value>
STATus:ALARm:ENABle?
```

Alarm Configuration Commands and Queries

(see page 43 for more information)

```
CONFigure:ALARm:HI <level>
CONFigure:ALARm:A <level>
CONFigure:ALARm:B <level>
CONFigure:ALARm:LO <level>
CONFigure:ALARm:RATE <rate>
CONFigure:ALARm:MUTE {0|1} or {NO|YES}

ALARm:HI?
ALARm:A?
ALARm:B?
ALARm:LO?
ALARm:RATE?
ALARm:MUTE?
```

Level and Usage Queries

(see page 44 for more information)

```
LEVel?
USAGe?
```

Length Configuration Commands and Queries

(see page 44 for more information)

```
CONFigure:LENgth:ZERO <lower_offset>
CONFigure:LENgth:SPAN <measured_span>

LENgth:ZERO?
LENgth:SPAN?
```

Fill Mode Control and Queries

(see page 45 for more information)

```
CONFigure:FILL:MODE {0|1|2} or {OFF|ON|AUTO}
CONFigure:FILL:TIMEout <minutes>

FILL:MODE?
FILL:TIMEout?
FILL:TIME:ELAPsed?
```

Calibration Commands and Queries

(see page 45 for more information)

```
CALibration:SELect {0|1} or {USER|FACTORY}, <cal_passcode>
CALibration:PERForm <cal_passcode>

CALibration?
```

Units Commands and Queries

(see page 46 for more information)

```
UNITs {0|1|2}
PERCent
INches
CM

UNITs?
```

4.2 Programming Overview

The Model 187 conforms to the SCPI (*Standard Commands for Programmable Instruments*) IEEE standard. The SCPI standard is an ASCII-based specification designed to provide a consistent command structure for instruments from various manufacturers.

The Model 187 also implements a status system for monitoring the state of the Model 187 through the *Standard Event*, *Alarm*, and *Status Byte* registers.

4.2.1 SCPI Language Introduction

SCPI commands conform to a tree structure where commands are grouped according to common keywords. For example, commands which set a Model 187 setup or operating parameter begin with the keyword `CONFigure`. The keywords are shown in upper case and lower case to indicate acceptable abbreviations. For the example keyword `CONFigure`, the user may send either the abbreviated form of `CONF`, or the entire keyword `CONFIGURE`. Any other form of the keyword is illegal and will generate an error.

Many commands also require multiple keywords to traverse the tree structure of the entire Model 187 command set. For example, commands associated with an alarm setting require the prefix of `CONFigure:ALARm`. Note that a colon (`:`) separates the keywords. No spaces are allowed before or after the colon. Parameters must be separated from the command keyword(s) by at least one space.

4.2.2 SCPI Status System

The Model 187 status system reports various conditions of the instrument in three register groups shown in Figure 4-1. The register groups consist of a condition and/or event register, and an enable register which controls the actions of specific bits within the condition or event registers.

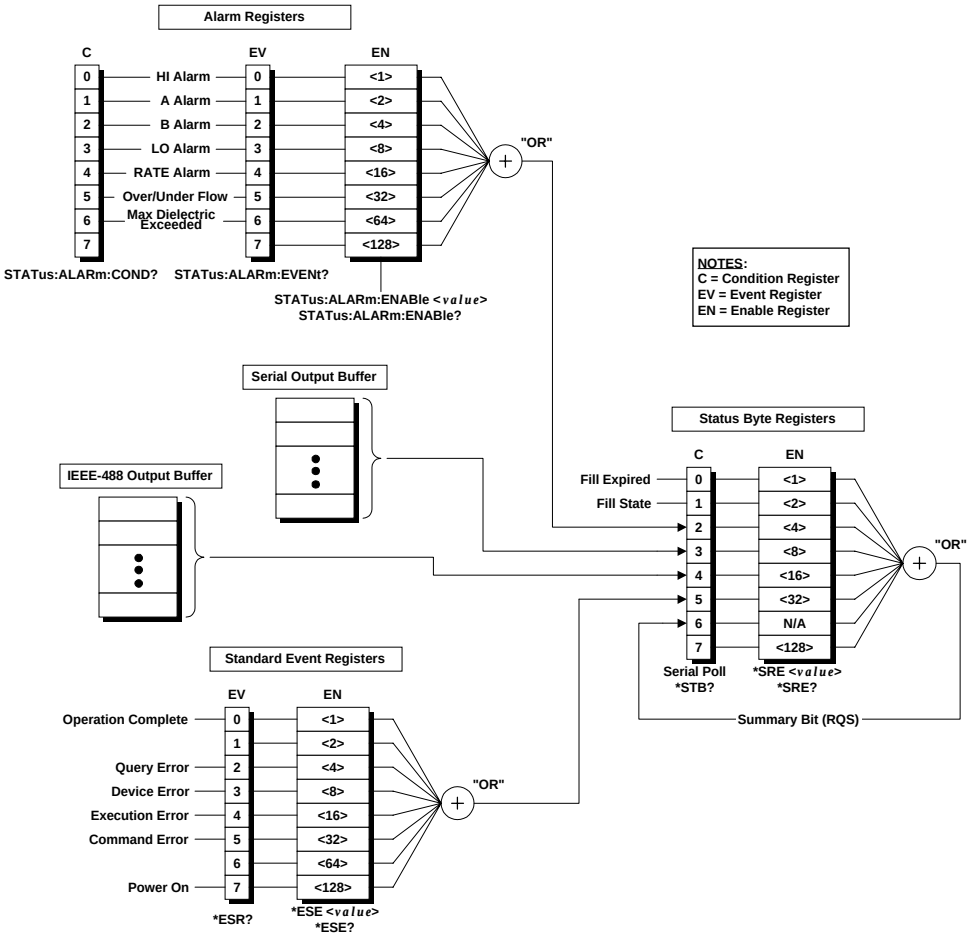


Figure 4-1. The Model 187 status system.

A *condition* register continuously monitors the state of the instrument. The bits of a condition register are updated in real time. A condition register is read-only and is not cleared when you read the register. A query of a condition register returns a decimal value in the appropriate output buffer which corresponds to the binary-weighted sum of all bits set in the register.

An *event* register latches various events. An event register is not buffered, therefore once a bit is set, further occurrences of that event are ignored. Once a bit is set in an event register, the bit remains set until the register is read (*ESR?) or a *CLS (clear status) command is issued. A query of an event register returns a decimal value in the appropriate output buffer which corresponds to the binary-weighted sum of all bits set in the register.

An *enable* register (or bitmask) defines which bits in an event register are reported to the Status Byte register group. An enable register can be both written and queried. The *CLS (clear status) command does not clear an

enable register. To enable or disable bits in an enable register, write a decimal value which corresponds to the binary-weighted sum of the bits you wish reported to the Status Byte register.

4.2.2.1 Status Byte Registers

The Status Byte register group reports conditions from the Standard Event register or output buffers. Data in the output buffer is immediately reported in the "IEEE-488 Message Available" bit (bit 4) or the "Serial Message Available" bit (bit 3). Clearing a bit in the Standard Event or Alarm Event registers will update the corresponding bit in the Status Byte register, according to the Standard Event and Alarm Event enable registers. Reading the pending messages in the output buffers will clear the appropriate "Message Available" bit. The bit definitions for the Status Byte register are defined in Table 4-1.

Table 4-1. Bit definitions for the Status Byte register.

Bit Number	Decimal Value	Definition
0 Fill Expired	**1**	"1" indicates the fill timeout period has expired.
1 Fill State	**2**	"1" indicates the controller output is energized. "0" indicates the output is de-energized.
2 Alarm Event	**4**	One or more enabled bits are set in the Alarm Event register.
3 Serial Message Available	**8**	The serial output buffer contains unread data.
4 IEEE-488 Message Available	**16**	The IEEE-488 output buffer contains unread data.
5 Standard Event	**32**	One or more enabled bits are set in the Standard Event register.
6 Status Byte Summary	**64**	One or more enabled bits are set in the Status Byte register.
7 *Not Used*	128	Always "0".

The Status Byte register provides the capability of generating a user-defined IEEE-488 service request (SRQ) by enabling the desired bits using the *SRE <*value*> command. If a Status Byte register bit is enabled, then when that bit is set, an SRQ is generated on the IEEE-488 bus. For example, if the command *SRE 2 is sent to the Model 187, then if the controller output is energized, the Model 187 will immediately generate an SRQ on the IEEE-488 bus.

Bit 1 of the Status Byte register, indicating that the controller output is energized, remains set until the controller output is de-energized via the front panel, a fill timeout, or by remote command. However, an SRQ is only asserted when the controller output *transitions from de-energized to energized*. Bits 3 and 4, indicating available data in an output buffer, are similar in that the SRQ is only asserted when data is first available in an output buffer. Bits 3 and 4 remain set until all data has been read from the respective output buffer.

The Status Byte *condition register* is cleared when:

- A `*CLS` command is executed.
- The Standard Event register is read (only bit 5 of the Status Byte register is cleared).
- The indicated condition no longer exists.

The Status Byte *enable register* is cleared when:

- The `*SRE 0` command is executed.
- The power is turned off and then back on, and the instrument was configured for `*PSC 1` (power-on status clear). The enable register setting is persistent if the Model 187 is configured for `*PSC 0` (no status clear on power-on).

4.2.2.2 Serial Polling and the Service Request (SRQ)

In order to use the SRQ feature of the Model 187, you must configure your host computer and IEEE-488 interface card to respond to the IEEE-488 service request. If the Status Byte enable register enables any bits of the Status Byte register, then the enabled bit(s) will generate an SRQ when they transition from “0” to “1”. The host computer can then poll the instruments on the IEEE-488 bus to determine which is asserting the service request line (the instrument which returns a response to a Serial Poll with bit 6 set).

> **Note**
>
> *If the Model 187 receives a Serial Poll, bit 6 of the Status Byte register is cleared and the service request line (SRQ) is cleared.*

If more than one bit is enabled in the Status Byte enable register, then the user must query the Status Byte register by issuing either a Serial Poll message, or the `*STB?` command. A Serial Poll is executed immediately by the Model 187 and may not reflect the effects of the most recently executed command. Use the `*OPC?` command for positive indication that all prior commands have been executed.

4.2.2.3 Reading the Status Byte using *STB?

The *STB? returns the contents of the Status Byte register, but it is processed in the command queue like any other command. The *STB? command returns the same result as a Serial Poll, however bit 6 of the Status Byte register is not cleared. Issuing an *STB? query does not clear an SRQ condition.

4.2.2.4 Using the Message Available Bit(s)

The "Message Available" bits (bits 3 or 4) of the Status Byte register can be used to determine when data is available to read into your host computer. The instrument clears the "Message Available" bits only after all data has been read from the output buffer(s).

The "Message Available" bits of the Status Byte register are useful for determining if *queries* have executed, however, they are not useful alone for determining if *commands* have completed execution, since commands do not provide return data.

4.2.3 Standard Event Registers

The Standard Event register group reports a power-on condition, various error conditions, and indicates when an operation has completed. Any or all of the Standard Events can be reported to the Status Byte register by enabling the corresponding bit(s) in the Standard Event enable register (see Figure 4-1). To set the Standard Event enable register, write a binary-weighted decimal value using the *ESE <*value*> command.

The bit definitions for the Standard Event register are provided in Table 4-2. To query the instrument for the details of a reported error in the Standard Event register, use the SYSTem:ERRor? query. See paragraph 4.6 for a complete discussion of the error buffer and messages.

The Standard Event *register* is cleared when:

- The *CLS (clear status) command is executed.
- The Standard Event register is queried using the *ESR? command.

The Standard Event *enable register* is cleared when:

- The *ESE 0 command is executed.
- The power is turned off and then back on, and the instrument was configured for *PSC 1 (power-on status clear). The enable register setting is persistent if the Model 187 is configured for *PSC 0 (no status clear on power-on).

Table 4-2. Bit definitions for the Standard Event register.

Bit Number	Decimal Value	Definition
0 Operation Complete	**1**	All commands prior to and including *OPC have been executed.
1 *Not Used*	2	Always “0”.
2 Query Error	**4**	A query error occurred. See the error messages in the -200 range.
3 Device Error	**8**	A device error occurred. See the error messages in the -400 range.
4 Execution Error	**16**	An execution error occurred. See the error messages in the -300 range.
5 Command Error	**32**	A command error occurred. See the error messages in the -100 range.
6 *Not Used*	64	Always “0”.
7 Power On	**128**	Power has been cycled since the last time the Standard Event register was read or cleared.

4.2.4 Alarm Registers

The Alarm register group reports the present condition of all alarms in the *Alarm Condition* register, and latches the ON state of all alarms in the *Alarm Event* register.

Any or all of the bits in the Alarm Event register can be reported to the Status Byte register by enabling the corresponding bit(s) in the Alarm Event enable register (see Figure 4-1). To set the Alarm Event enable register, write a binary-weighted decimal value using the STATus:ALARm:ENABle <*value*> command.

The bit definitions for the Alarm Condition and Event registers are identical and are provided in Table 4-3. The Alarm Condition register is continually updated for each level measurement is available. The Alarm Event register latches the occurrences of each alarm and the respective bit(s) remain set until cleared.

The Alarm Event *register* is cleared when:

- The *CLS (clear status) command is executed.

- The Alarm Event register is queried using the `STATus:ALARm:EVENt?` command.

The Alarm Event *enable register* is cleared when:

- The `STATus:ALARm:ENABle 0` command is executed.
- The power is turned off and then back on, and the instrument was configured for `*PSC 1` (power-on status clear). The enable register settings are persistent if the Model 187 is configured for `*PSC 0` (no status clear on power-on).

Table 4-3. Bit definitions for the Alarm Condition and Event registers.

Bit Number	Decimal Value	Definition
0 HI Alarm	**1**	"HI" alarm condition or event.
1 A Alarm	**2**	"A" alarm condition or event.
2 B Alarm	**4**	"B" alarm condition or event.
3 LO Alarm	**8**	"LO" alarm condition or event.
4 RATE Alarm	**16**	"RATE" alarm condition or event.
5 Over/Under Flow	**32**	The reference sensors are either both submerged or exposed.
6 Maximum Dielectric Exceeded	**64**	The maximum allowable dielectric has been exceeded. The maximum allowable value is recorded on the first page of this manual.
7 *Not Used*	128	Always "0".

4.2.5 Command Handshaking

The Model 187 provides an internal command queue that can store up to 4 commands or queries. However, it is possible that the host computer can overwhelm the command queue by sending commands faster than the Model 187 can execute. If the Model 187 cannot process a command due to a full command queue, the command is ignored and the `-303,"Input overflow"` error is reported.

Handshaking is generally not a concern unless more than 4 *commands* are sent sequentially. If a *query* is sent, the user will normally wait for return data for the queries before proceeding to send the next query or command. In the case of sending numerous *commands* in sequence, there are two methods available to help prevent command queue overflows which are discussed below.

4.2.5.1 Using the *OPC Command

The *OPC command is executed within the normal command queue. Upon completed execution of the *OPC command, the "Operation Complete" bit (bit 0) of the Standard Event register will be set.

If the operator has so configured the Standard Event and Status Byte enable registers, the *OPC command can generate an IEEE-488 service request when execution completes (see Figure 4-1). If using the serial port, the *OPC? query is a better alternative since a response is returned directly to the requesting communications interface.

An example of a sequence of commands using the *OPC command to handshake is the following:

```
PERCENT; CONF:ALARM:A 50.0; CONF:ALARM:B 20.0; *OPC;
```

The above example sets the remote units to percent, the "A" alarm to 50.0%, the "B" alarm to 20.0%, and sends *OPC as the 4th command for determining when execution all of the commands (including *OPC) has completed. If the Standard Event and Status Byte enable registers are correctly configured, the *OPC command will then result in an IEEE-488 service request when execution completes. Alternately, the Serial Poll function of the IEEE-488 bus may be used to determine completion of the command.

4.2.5.2 Using the *OPC? Query

The *OPC? query is similar to the *OPC command, but instead of setting the "Operation Complete" bit of the Standard Event register, the *OPC? query returns a "1" (plus termination characters) to the requesting remote interface when executed. Using *OPC? is often the most straightforward solution for determining completed command execution. It is also unambiguous since the result is returned directly to the requesting remote communication interface.

4.2.6 Remote Units

The Model 187 supports a *remote units setting* that is maintained separately from the units selected via the front panel keypad. The remote units setting is retained between power-ups. If the PERCENT command is sent to the remote interface, the remote units for both remote interfaces is set to percent. All alarm values should then be sent as a percent value, and all return level data and alarm queries are returned in units of percent.

The UNITs? query returns the currently selected remote units, e.g. the percent setting would return 0,"PERCENT".

4.3 RS-232/422 Configuration

The Model 187 allows several parameters related to the RS-232/422 interface to be configured by the user. See the *Comm Menu* description in paragraph 3.3.10 on page 22 for illustrations of the menus provided for configuring the Model 187 serial interface.

The *Comm Menu* provides menus to configure the following (the defaults are shown in bold):

- *Baud Rate*: 1200, 2400, 4800, **9600**
- *Parity and Data Bits*: Even Parity/7 Data Bits, Odd Parity/7 Data Bits, **No Parity/8 Data Bits**
- *Number of Start Bits*: **1 bit** (fixed)
- *Number of Stop Bits*: **1 bit** or 2 bits
- *Flow Control*: **None** or SW (XON/XOFF)

4.3.1 Serial Port Connector

An IBM-compatible computer's serial port can be directly connected to the Model 187 via a standard DB9 female-to-DB9 male PC modem cable if the Model 187 is configured for RS-232. Refer to your computer's documentation to determine which serial ports are available on your computer and the required connector type. The cable to connect two DB9 connectors is wired directly, i.e. pin 1 to pin 1, pin 2 to pin 2, etc. If a DB25 connector is required at the computer interface, the connector translation is provided in the *Appendix*.

The Model 187, when configured for RS-232, uses only three wires of the rear-panel DB9 connector: pin 2 (transmit), pin 3 (receive), and pin 7 (common). The RS-232 (and RS-422) pinout is fully documented on page 60 in the *Appendix*. The Model 1887 is classified as a DCE (Data Communication Equipment) device since it transmits data on pin 3 and receives data on pin 2. The computer or terminal to which the Model 187 is attached must do the opposite, i.e., transmit on pin 2 and receive on pin 3 (the requirements for a DTE, or Data Terminal Equipment device). If a serial-to-parallel converter is used, it must be capable of receiving data on pin 3 or the cable connected to the Model 187 must interchange the wires between pins 2 and 3.

Optional RS-422 connector pinout is provided in Table A-4 on page 61.

4.3.2 Termination Characters

All commands and queries are transmitted and received as ASCII values and are case insensitive. The Model 187 always transmits <*CR*><*LF*> (i.e. a *carriage return* followed by a *linefeed*) at the end of an RS-232

transmission. The Model 187 can accept <*CR*>, <*LF*>, <*CR*><*LF*>, or <*LF*><*CR*>, or a semicolon (**;**) as termination characters from an external computer.

4.3.3 Flow Control Modes

The operator may select between two flow control modes for data transfers between the host device and the Model 187:

- *None*: Data is sent and received over the interface with no flow control. When using this mode, avoid sending more than 64 characters without stopping or reading a response.
- *Software*: Also referred to as *XON/XOFF*. Software handshaking uses special embedded characters in the data stream to control the flow. If the Model 187 is asked to return data, it continues data output until the XOFF character (13 Hex) is received. Once an XOFF character is received, an XON character (11 Hex) is required for data transmission to continue.

  The Model 187 also sends XON/XOFF when its internal serial port buffer reaches a "high-water" mark. The host device should suspend transmission on receipt of an XOFF character from the Model 187, and resume when an XON character is received.

  Note

  The XON/XOFF flow control should not be used as a substitute for command handshaking as documented in paragraph 4.2.5. XON/XOFF characters are not generated in the case of "input overflow" errors (error number -303).

4.4 IEEE-488 Configuration

The Model 187 allows the primary IEEE-488 address of the Model 187 to be configured by the user. See the *Comm Menu* description in paragraph 3.3.10 on page 22 for an illustration of the menu provided for configuring the Model 187 IEEE-488 address.

4.4.1 Termination Characters

All commands are transmitted and received as ASCII values and are case insensitive. The Model 187 always transmits <*LF*> with EOI as the termination for return data. The Model 187 can accept <*CR*>, <*LF*>, or <*LF*> with EOI as termination characters from an external IEEE-488 interface. More than one command may be sent before a terminator if each command is separated with a semicolon (**;**).

4.4.2 Device Clear

The Device Clear is a low-level IEEE-488 bus message which you can use to return the instrument to a responsive state if communication appears to stall. The status registers and the error queue are left unchanged when a Device Clear message is received. Device Clear performs the following actions:

- The Model 187's serial and IEEE-488 output buffers are cleared.
- The Model 187 is prepared to accept a new command.

> **Note**
>
> *For the serial interface, a Device Clear can be initiated by sending the <Ctrl-C> (ASCII code 03) character.*

4.5 Command Reference

The following paragraphs present all instrument commands and queries in related groups and a detailed description of the function of each command or query is provided. Examples are also provided where appropriate. Return strings may be up to 80 characters in length.

4.5.1 System-Related Commands

- `*IDN?`

Return the instrument's identification string. The identification string contains the AMI model number and firmware revision code.

- `*RST`

Resets the instrument. This is equivalent to cycling the power to the instrument using the power switch. All non-volatile calibration data and battery-backed memory is restored. Status is cleared according to the `*PSC` setting.

- `*TST?`

Performs a self-test. Currently always returns "1" plus a diagnostic code useful for troubleshooting by an Authorized AMI Technical Support Representative.

- *<Ctrl-C>*

Equivalent to sending a Device Clear message over the IEEE-488 interface. *<Ctrl-C>* is only accepted from the serial interface. This clears the output buffers of the instrument and prepares the instrument for a new command. Status registers are unaffected. *<Ctrl-C>* corresponds to ASCII code 03.

- SYSTem:LOCal

Enables all front panel controls. All front panels controls are enabled by default after a power-up or *RST command.

- SYSTem:REMote

Disables all front panel controls.

- SYSTem:ERRor?

Queries the instrument's error buffer. Up to 10 errors are stored in the instrument's error buffer. Errors are retrieved in first-in-first-out (FIFO) order. The error buffer is cleared by the *CLS (clear status) command or when the power is cycled. Errors are also cleared as they are read. See page 47 for a complete description of the error buffer and messages.

4.5.2 Status System Commands

The status system register groups and commands are illustrated in Figure 4-1 on page 31.

- *STB?

Returns the contents of the Status Byte register. The *STB? command is similar in function to an IEEE-488 Serial Poll, however the command is executed in the order received as any other command. In contrast to the IEEE-488 Serial Poll, *STB? does not clear an SRQ condition or the "Summary Bit" (bit 6) of the Status Byte register.

- *SRE <*enable_value*>

Enables bits in the Status Byte register to be reported in the "Summary Bit" (bit 6) of the Status Byte register. To enable bits, you must write a decimal <*enable_value*> which corresponds to the binary-weighted sum of the bits you wish to enable. Refer to Table 4-1 on page 32 for more information. For example, to enable controller output state only in the "Summary Bit" of the Status Byte register, send the command:

```
*SRE 2;
```

- *SRE?

The *SRE? query returns a decimal sum which corresponds to the binary-weighted sum of the bits enabled by the last *SRE command.

- *CLS

Clears the Standard Event register and the error buffer.

- *ESR?

Returns the contents of the Standard Event register as a binary-weighted sum.

- *ESE <*enable_value*>

Enables bits in the Standard Event register to be reported in the "Standard Event" bit (bit 5) of the Status Byte register. To enable bits, you must write a decimal <*enable_value*> which corresponds to the binary-weighted sum of the bits you wish to enable. Refer to Table 4-2 on page 35 for more information. For example, to enable *all* categories of error messages to be reported in bit 5 of the Status Byte register, send:

```
*ESE 60;
```

- *ESE?

The *ESE? query returns a decimal sum which corresponds to the binary-weighted sum of the bits enabled by the last *ESE command.

- *PSC {0|**1**}

Power-On Status Clear. If *PSC 1 is in effect, the Standard Event enable register and the Status Byte enable register are cleared at power on. If *PSC 0 is in effect, the enable registers are not cleared at power on. The default setting is "1".

- *PSC?

Returns the *Power-On Status Clear* setting currently in effect. A value of "0" indicates the enable registers are not cleared at power on; a value of "1" indicates the enable registers are cleared at power on.

- *OPC

Sets the "Operation Complete" bit (bit 0) of the Standard Event register when executed. See page 37 for a complete discussion.

- *OPC?

Returns "1" to the requesting interface when executed. See page 37 for more information.

- STATus:ALARm:CONDition?

Returns the contents of the Alarm Condition register as a binary-weighted sum.

- STATus:ALARm:EVENt?

Returns the contents of the Alarm Event register as a binary-weighted sum.

- STATus:ALARm:ENABle <*enable_value*>

Enables bits in the Alarm Event register to be reported in the "Alarm Event" bit (bit 2) of the Status Byte register. To enable bits, you must write a decimal <*enable_value*> which corresponds to the binary-weighted

sum of the bits you wish to enable. Refer to Table 4-3 on page 36 for more information. For example, to enable *all* alarms to be reported in bit 2 of the Status Byte register, send:

```
STATus:ALARm:ENABle 127;
```

- `STATus:ALARm:ENABle?`

Returns a decimal sum which corresponds to the binary-weighted sum of the bits enabled by the last `STATus:ALARm:ENABle` <*enable_value*> command.

4.5.3 Alarm Configuration Commands and Queries

The alarm configuration commands and queries provide read/write access to the alarm settings available within the HI, A, B, LO, RATE, and MUTE menus.

- `CONFigure:ALARm:HI` <*level*>

Sets the HI alarm limit in the presently selected remote units.

- `ALARm:HI?`

Returns the HI alarm value in the presently selected remote units.

- `CONFigure:ALARm:A` <*level*>

Sets the A alarm setpoint in the presently selected remote units.

- `ALARm:A?`

Returns the A alarm setpoint in the presently selected remote units.

- `CONFigure:ALARm:B` <*level*>

Sets the B alarm setpoint in the presently selected remote units.

- `ALARm:B?`

Returns the B alarm setpoint in the presently selected remote units.

- `CONFigure:ALARm:LO` <*level*>

Sets the LO alarm limit in the presently selected remote units.

- `ALARm:LO?`

Returns the LO alarm value in the presently selected remote units.

- `CONFigure:ALARm:RATE` <*rate*>

Sets the RATE alarm limit in the presently selected remote units per minute. The RATE alarm applies to both positive (fill) or negative (empty) usage rates.

- `ALARm:RATE?`

Returns the RATE alarm value in the presently selected remote units per minute.

- `CONFigure:ALARm:MUTE {0|1}` *or* `{NO|YES}`

Mutes the continuous audible alarm if a HI, LO, or Over/Under Flow alarm condition exists. Error conditions will still report as a short audible beep. “0” or “NO” enables the continuous audible alarm. “1” or “YES”disables (or mutes) the continuous audible alarm.

- `ALARm:MUTE?`

Returns “1” if the continuous audible alarm is muted, “0” otherwise.

4.5.4 Level and Usage Queries

The level and usage queries return the current level and usage rate in the presently selected remote units.

- `LEVel?`

Returns the level in the presently selected remote units.

- `USAGe?`

Returns the usage rate in the presently selected remote units per minute.

4.5.5 Length Configuration Commands and Queries

The length configuration commands and queries control the zero offset and measured span settings for the Model 187. For more information regarding the length configurations, see paragraph 3.1.3 on page 14. It is important to limit the zero offset and measured span settings so as to only measure the span between the reference sensors.

Attempting to set or query for the length settings in the percent remote units will generate an error. The selected remote units must be inches or centimeters.

- `CONFigure:LENgth:ZERO <`*zero_offset*`>`

Configures the “zero point”, or the zero offset from the bottom of the sensor which will function as the “zero level”. The argument must be in the selected remote units.

- `LENgth:ZERO?`

Returns the “zero point” or zero offset in the selected remote units.

• `CONFigure:LENgth:SPAN <`*measured_span*`>`

Configures the measured span above the “zero point” in the selected remote units.

• `LENgth:SPAN?`

Returns the measured span in the selected remote units.

4.5.6 Fill Mode Control and Queries

The mode of operation and the timeout of the fill function may be controlled through the remote interfaces.

• `CONFigure:FILL:MODE {`**`0`**`|1|2}` *or* `{`**`OFF`**`|ON|AUTO}`

Configures the operating mode of the controller output receptacle on the rear panel of the Model 187. See paragraph 3.1.6 on page 16 for more information.

• `FILL:MODE?`

Returns a “0” indicating the controller output receptacle is OFF, a “1” indicating the controller output receptacle is ON, or a “2” indicating the controller output receptacle is in AUTO fill mode.

• `CONFigure:FILL:TIMEout <`*minutes*`>`

Configures the fill timeout in minutes for the AUTO mode of the controller output receptacle. If the target vessel does not reach the “A” setpoint within the fill timeout period, the fill cycle is interrupted. See paragraph 3.1.7 on page 16 for more information.

• `FILL:TIMEout?`

Returns the fill timeout period in minutes.

• `FILL:TIME:ELAPsed?`

Returns the elapsed time in minutes of the current AUTO fill cycle. “0.0” is returned if the fill mode is OFF, ON, or if the AUTO fill cycle period has exceeded the fill timeout period. The Status Byte register provides bit 0, which when set, indicates a fill cycle has expired.

4.5.7 Calibration Commands and Queries

The calibration commands and queries provide the user with a method of selecting between the USER and FACTORY calibrations, as well as initiating a USER calibration remotely.

• CALibration:SELect {0|**1**} *or* {USER|**FACTORY**}, <*cal_passcode*>

Selects between the USER and FACTORY calibrations. For example, the command:

```
CAL:SELECT USER, 1234;
```

selects the USER calibration (if available) and requires that the calibration passcode ("1234" in this example) be provided as a parameter. If the calibration passcode is missing or incorrect, the Model 187 will beep indicating an error. Also, the Model 187 will only allow selection of the USER calibration if the user has previously performed a USER calibration via the front panel interface or remotely.

• CALibration?

Returns the currently selected calibration.

0,"USER" is returned if the USER calibration is currently selected.

1,"FACTORY" is returned if the FACTORY calibration is selected.

• CALibration:PERForm <*cal_passcode*>

Performs a USER calibration if the correct calibration passcode is provided as a parameter. The USER calibration is also made the current calibration selection upon completion.

4.5.8 Remote Units Commands and Queries

The remote units commands and queries provide the capability of selecting between units of percent, inches, and centimeters for all parameters and return values for level and alarm commands and queries. The remote units are independent of the display units selected via the front panel. The remote units setting is persistent between power-ups of the Model 187.

• UNITs {**0**|1|2}

Selects between the percent (0), inches (1), and centimeters (2) units. For example, the command:

```
UNITS 1;
```

selects inches for the remote units.

• UNITs?

Returns the currently selected units.

0,"PERCENT" is returned if the remote units are percent.

1,"INCHES" is returned if the remote units are inches.

2,"CM" is returned if the remote units are centimeters.

- PERCent

Sets the remote units to percent.

- INches

Sets the remote units to inches.

- CM

Sets the remote units to centimeters.

4.6 Error Messages

If an error occurs, the Model 187 will beep, load the internal error buffer with the error code and description, and set the appropriate bits in the standard event and status byte registers if enabled by the user. Error codes are returned with a negative 3 digit integer, then a comma, and then a description enclosed in double quotes.

Use the SYSTem:ERRor? query to retrieve the errors in first-in-first-out (FIFO) order. Errors are removed from the internal error buffer as they are read. The Model 187 can store up to 10 errors.

If more than 10 errors have occurred, the last error stored in the internal error buffer is replaced with -304,"Error buffer overflow". No additional errors are stored until you have cleared at least one error from the buffer. If no errors have occurred and the SYSTem:ERRor? query is sent to the Model 187, the instrument will return:

```
0,"No errors"
```

Error strings may contain up to 80 characters. Errors are classified in the following categories: *command errors*, *query errors*, *execution errors*, and *device errors*. Each category corresponds to the identically named bit in the standard event register (see page 31). If an error occurs in any one of the categories, the corresponding bit in the standard event register is set and remains set until cleared by the user.

4.6.1 Command Errors

`-101,"Unrecognized command"`

The command string sent was not identified as valid. Check the command string for invalid characters or separators, syntax errors, or for errors in the mnemonics. Spaces are not allowed before or after colon separators, and at least one space must separate a command string from the parameter(s).

`-102,"Invalid argument"`

The argument provided as a parameter for the command was invalid. *Value* arguments must be of the following form:

- an optional plus or minus sign,
- a sequence of decimal digits, possibly containing a single decimal point, and
- an optional exponent part, consisting of the letter `e` or `E`, an optional sign, and a sequence of decimal digits.

Enable_value arguments must be within the inclusive range of 0 to 255.

`-103,"Non-boolean argument"`

The command required a parameter in the form of 0 or 1. No other form of the parameter is allowed.

`-104,"Missing parameter"`

The command required at least one argument which was not found before the termination character(s).

`-105,"Out of range"`

At least one of the parameter values received was out of the valid range. Refer to the *Menu Reference* section beginning on page 18 for the acceptable ranges for each instrument setting.

`-106,"Attempted to set length in percent"`

The user attempted to set the zero offset or measured span in the remote units of percent. The remote units must be inches or centimeters.

`-107,"Incorrect passcode"`

The user attempted to modify a calibration setting but failed to provide the correct calibration passcode.

`-108,"USER cal not available"`

The user attempted to select the USER calibration when none exists. The operator must perform a USER calibration in order to enable selection.

4.6.2 Query Errors

`-201,"Unrecognized query"`

The query string sent (identified as a query by a ?) was not identified as valid. Check the query string for invalid characters or separators, syntax errors, or for errors in the mnemonics. Spaces are not allowed before or after colon separators.

`-202,"Query interrupted"`

A new query was processed before the return string of a previous query had been completely transmitted to the host. The new query clears the remaining data and replaces it with the new return string.

`-203,"Query for length in percent"`

The operator attempted to query for the zero offset or measured span in remote units of percent. The remote units must be inches or centimeters.

4.6.3 Execution Errors

`-301,"Input overflow"`

The four input buffers are all occupied with unprocessed commands or queries. The command or query is lost. Review the handshaking section on page 36 for directions for avoiding input overflow errors.

`-302,"Error buffer overflow"`

More than 10 errors have occurred. For further errors to be recorded in the internal buffer, at least one error must be cleared.

4.6.4 Device Errors

`-401,"Checksum failed"`

The non-volatile memory which stores the calibration data for the Model 187 is corrupted. Contact an Authorized AMI Technical Representative for further instructions. Do not continue to use the Model 187 for level measurements.

`-402,"Serial framing error"`

The baud rate of the Model 187 and host device are not identical. Both the Model 187 and host device must be set to the identical baud rate.

`-403,"Serial parity error"`

The number of data bits and/or the parity of the Model 187 and the host device are not identical.

`-404,"Serial data overrun"`

The received buffer of the Model 187 was overrun. Either switch to software handshaking (XON/XOFF), or decrease the baud rate.

5 Service

5.1 Model 187 Maintenance

The Model 187 was designed and manufactured to give years of reliable service. The only routine maintenance required is to keep the exterior surfaces of the instrument clean by gently wiping with a damp cloth moistened with a mild detergent.

5.2 Model 187 Troubleshooting Hints

The following paragraphs serve as an aid to assist the user in troubleshooting a potential problem with the Model 187 within a cryogenic level measurement system. If the user is not comfortable in troubleshooting the system, you may contact an AMI Technical Support Representative for assistance. Refer to “Additional Technical Support” on page 56.

This instrument contains CMOS components which are susceptible to damage by Electrostatic Discharge (ESD). Take the following precautions whenever the cover of the instrument is removed.

1. Disassemble the instrument only in a static-free work area.
2. Use a conductive workstation or work area to dissipate static charge.
3. Use a high resistance grounding wrist strap to reduce static charge accumulation.
4. Ensure all plastic, paper, vinyl, Styrofoam® and other static generating materials are kept away from the work area.
5. Minimize the handling of the instrument and all static sensitive components.
6. Keep replacement parts in static-free packaging.
7. Do not slide static-sensitive devices over any surface.
8. Use only antistatic type solder suckers.
9. Use only grounded-tip soldering irons.

5.2.1 The Model 187 does not appear to be energized with the power switch in the POWER (I) position.

1. Ensure that the Model 187 is energized from a power source of proper voltage.

   Warning

   If the instrument has been found to have been connected to an incorrect power source, return the instrument to AMI for evaluation to determine the extent of the damage. Frequently, damage of this kind is not visible and must be determined using test equipment. Connecting the instrument to an incorrect power source could damage the internal insulation and/or the ground conductors, thereby, possibly presenting a severe life-threatening electrical hazard.

2. Verify continuity of the line fuse, F1, located on the instrument printed circuit board.

   Warning

   This procedure is to be performed only when the instrument is completely de-energized by removing the power-cord from the power receptacle. Failure to do so could result in personnel coming in contact with high voltages capable of producing life-threatening electrical shock.

   a. Ensure the instrument is de-energized by disconnecting the power cord from the power source. Disconnect the power cord from the connector located on the rear panel of the instrument.

   b. Remove the instrument top cover and check the fuse F1 for continuity.

   c. If the fuse is bad, replace with a fuse of identical rating.

   Caution

   Installing fuses of incorrect values and ratings could result in damage to the instrument in the event of component failure.

   Note

   The proper fuse for this instrument is an IEC Type F, 5x20mm fuse rated for 0.315 Amperes, quick acting. The fuse will be labeled with the current rating and marked with an F, or red color code to denote quick acting.

d. Replace the fuse and securely fasten the instrument top cover. Reconnect the power-cord.

3. Verify the input voltage selector switch on the instrument's printed circuit board is in the proper position for the available input power. Checking the input voltage selector requires removal of the top cover of the instrument. Observe the same safety procedures as presented in step 2, above.

4. If the display appears blank but the instrument power-up appears otherwise normal (all the LEDs energized), then the contrast of the LCD display may need adjustment. The LCD display should always be visible (especially when looking up at the unit), but may be only faintly visible if set to a low contrast percentage. See paragraph 3.3.10.1 on page 23 for specific directions for adjusting the display contrast.

5.2.2 The Model 187 does not remember the alarm setpoints after power is removed.

Warning

This procedure is to be performed only when the instrument is completely de-energized by removing the power-cord from the power receptacle. Failure to do so could result in personnel coming in contact with high voltages capable of producing life-threatening electrical shock.

1. Ensure the instrument is de-energized by disconnecting the power cord from the power source. Disconnect the power cord from the connector located on the rear panel of the instrument.

2. Remove the instrument top cover and replace the computer memory backup battery, BT1.

Note

When replacing the battery, replace with a 3.6 volt AA-size lithium cell (International size reference: ER14505). Comply with the polarity markings adjacent to the battery holder on the printed wiring board.

Warning

Do not attempt to recharge the Lithium cell. Attempts at recharging may cause the cell to vent or explode.

5.2.3 The Model 187 displays “Over/Under Flow”.

1. The vapor and liquid reference plate sensors are either both submerged or exposed. The vapor reference plates should be exposed at all times. The liquid reference plates should be submerged at all times.

2. The dielectric between the vapor and liquid is not sufficiently different to allow for operation of the Model 187. The dielectric difference between the vapor and liquid must be greater than 1.0%. Operation of the Model 187 near the critical point of cryogenics (where the dielectric of the vapor ≈ dielectric of the liquid) is not recommended.

5.2.4 The Model 187 displays “Max Diel Exceeded”.

1. The maximum dielectric has been exceeded for at least one sensing element. The maximum allowable dielectric value is recorded on the first page of this manual. If the dielectric of the media in which any of the sensing elements is submerged exceeds the maximum allowable value, the measurement section of the Model 187 may become saturated and accurate measurements cannot be obtained.

2. If a sensing element is shorted, this can also result in the “Max Diel Exceeded” error. Contact an AMI Technical Support Representative for assistance in determining which sensing element may be shorted. Moisture present on the sensing element or in the BNC connectors can also cause a shorted condition.

   A pack of non-conductive electrical connection lubricant (ECL) has been included with the liquid level sensor to reduce the possibility of moisture in the BNC connectors. Apply a small amount of ECL to any of the BNC connectors that may be exposed to moisture. Mate the doped connectors then remove any excess ECL from the outside of the connector. Added protection can be achieved by covering the doped connections with a short section of heat-shrink tubing.

   Note: MSDS sheets for the ECL are available upon request.

5.2.5 The liquid level unexpectedly drops rapidly as the tank level approaches 100%.

1. The vapor reference plate sensor is most likely becoming submerged in liquid. Verify that the upper limit of the measured span does not exceed the lowest point of the vapor reference plate sensor (see “Configuring the Length Settings” on page 14.) and lower the liquid level if necessary.

5.2.6 The liquid level unexpectedly rises rapidly as the tank level approaches 0%.

1. The liquid reference plate sensor is most likely becoming exposed to vapor. Verify that the zero offset does not fall below the highest point of the liquid reference plate sensor (see “Configuring the Length Settings” on page 14.).

5.2.7 The USER and FACTORY calibrations do not yield the same liquid level.

1. It is possible that the USER calibration was not performed properly. Review paragraph 3.3.11 on page 24 for the proper procedure for a USER calibration.

2. If the installed length of cable from the Model 187 instrument to the AMI sensor *significantly exceeds* 6 feet, an error of up to 5.0% is within expected tolerances. In this case, the USER calibration is more accurate than the FACTORY calibration. Please contact an AMI Technical Support Representative for further information regarding recommendations for a USER calibration.

5.2.8 The Model 187 is not responding to remote communications commands.

1. Verify your communications cable integrity and wiring. See the *Appendix* for RS-232/422 connector pinouts.

2. Check to make sure you are sending the correct termination to the instrument. If you are using RS-232 or the RS-422 option, make sure the baud rate, number of stop bits, and data bits/parity settings match the setting of the host device. If you are using the IEEE-488 option, check the primary address setting and make sure the controller software is set to query the instrument at the primary address selected.

3. Check your host communications software and make sure it is recognizing the return termination characters from the instrument. For RS-232 communication, the return termination characters are <*CR*><*LF*>. For IEEE-488, the return message termination characters are <*LF*> with EOI.

4. If the instrument is responding repeatedly with errors, try a device clear command (DCL) or powering the instrument off and then back on. Be sure you are sending valid commands.

If you experience continued trouble with the IEEE-488 interface, you may have an incompatible IEEE-488 card in your host computer. In the past, AMI has found subtle differences between manufacturers of IEEE-488

cards that have introduced communication errors. AMI attempts to establish compatibility with as many products as possible, however it is difficult to test every card available. Contact AMI directly if you have thoroughly checked your setup and continue to experience problems with the IEEE-488 interface.

5.3 Additional Technical Support

If the cause of the problem cannot be located, contact an AMI Technical Support Representative at (865) 482-1056 for assistance. The AMI technical support group may also be reached by Internet e-mail at **support@americanmagnetics.com**. Additional technical information, latest software releases, etc. are available at the AMI World Wide Web site at:

http://www.americanmagnetics.com

Do not return the Model 187 or other AMI system components to AMI without prior return authorization.

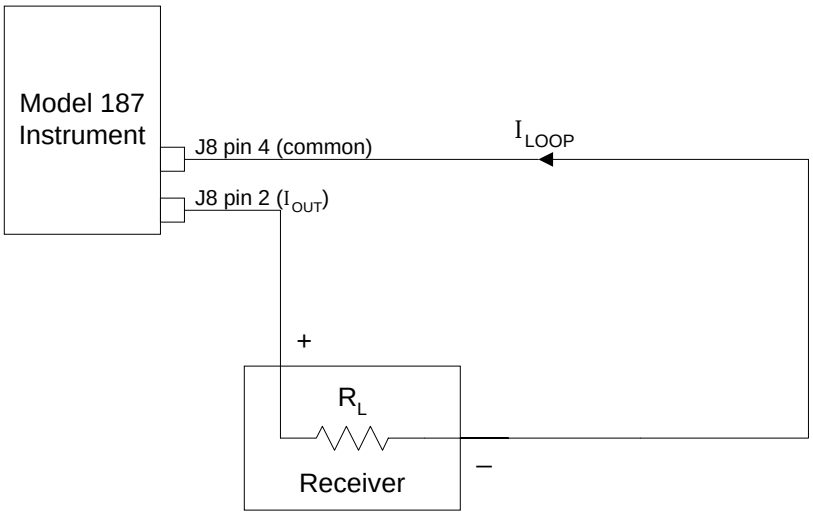
5.4 Return Authorization

Items to be returned to AMI for repair (warranty or otherwise) require a return authorization number to ensure your order will receive proper attention. Please call an AMI representative at (865) 482-1056 for a return authorization number before shipping any item back to the factory.

Appendix

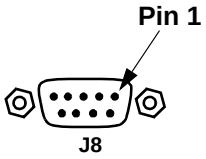
A.1 4-20 mA Current Loop Option

The 4-20 mA output utilizes pins 2 and 4 of connector J8. When the Model 187 is configured for the 4-20 mA current loop option, the 0-10 VDC analog output from connector J8 is not available. The figure below shows the wiring diagram for the receiver. The 4-20 mA output has a maximum compliance of 11.5 VDC.



A.2 Auxiliary Connector J8 Pinout

Pin	Function
1	Not used
2	4-20 mA current loop output (optional feature)
3	0-10 VDC output (optional feature)
4	Analog output common
5 & 6	Lo level relay contacts (dry)
7 & 8	Hi level relay contacts (dry)
9	Not used



The HI level and LO level contacts are provided for external use by the customer. When a HI or LO level condition exists, the respective contact pairs are closed. The HI and LO setpoints provide 0.05% hysteresis, however the respective contact pairs still may “chatter” if the liquid sloshes, bubbles, etc.

The HI level and LO level contacts also provide positive indication of a power-off condition. With a power-off condition, *both* the HI level and LO level contacts will be closed, which is a state unique to the power-off condition.

The following table provides the specifications for the relay contacts:

Max switching VA	10
Max switching voltage	200 VDC
Max switching current	0.5 A
Max continuous current	1.5 A
Dielectric between contacts	200 VDC minimum

A.3 IEEE-488 Connector

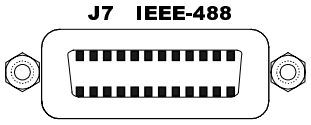


Table A-1. IEEE-488 female connector J7 description.

Pin	Mnemonic	Description
1	DIO1	Data In/Out Bit 1
2	DIO2	Data In/Out Bit 2
3	DIO3	Data In/Out Bit 3
4	DIO4	Data In/Out Bit 4
5	EOI	End or Identify
6	DAV	Data Valid
7	NRFD	Not Ready for Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Cable Shield (connected to 187 chassis gnd)
13	DIO5	Data In/Out Bit 5
14	DIO6	Data In/Out Bit 6
15	DIO7	Data In/Out Bit 7
16	DIO8	Data In/Out Bit 8
17	REN	Remote Enable
18	GND	Ground, Twisted pair with DAV
19	GND	Ground, Twisted Pair with NRFD
20	GND	Ground, Twisted Pair with NDAC
21	GND	Ground, Twisted Pair with IFC
22	GND	Ground, Twisted Pair with SRQ
23	GND	Ground, Twisted Pair with ATN
24	SGND	Signal Ground

A.4 RS-232/422 Connector

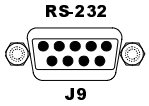


Table A-2. PC (DB-25)-to-Model 187 connections for **RS-232** operation.

PC (DTE) DB-25 Pin	**Model 420 (DCE)** DB-9 Pin	**DTE Function**
2	3	TD
3	2	RD
4	7	RTS
5	8	CTS
6	6	DSR
7	5	GND
8	1	DCD
20	4	DTR
22	9	RI

Table A-3. PC (DB-9)-to-Model 187 connections for **RS-232** operation.

PC (DTE) DB-9 Pin	**Model 420 (DCE)** DB-9 Pin	**DTE Function**
3	3	TD
2	2	RD
7	7	RTS
8	8	CTS
6	6	DSR
5	5	GND
1	1	DCD
4	4	DTR
9	9	RI

Table A-4. EIA-530 Device-to-Model 187 connections for **RS-422** operation.

EIA-530 Device (DTE) DB-25 Pin	**Model 420 (DCE)** DB-9 Pin	**DTE Function**
2	9	TX–
3	1	RX–
4	7	RTS–
5	8	CTS–
13	6	CTS+
14	3	TX+
16	2	RX+
19	4	RTS+

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